

VEHICLE COCKPIT ASSEMBLIES HAVING INTEGRATED DASH
INSULATORS, INSTRUMENT PANELS AND FLOOR COVERINGS, AND
METHODS OF INSTALLING SAME WITHIN VEHICLES

RELATED APPLICATION

This application is a continuation-in-part of
U.S. Application No. 10/256,695, filed September 27,
2002, the disclosure of which is incorporated herein by
5 reference in its entirety as if set forth fully herein.

FIELD OF THE INVENTION

The present invention relates generally to
vehicles and, more particularly, to trim components
10 utilized within vehicles.

BACKGROUND OF THE INVENTION

It is generally considered desirable to reduce
the level of noise within a vehicle passenger
15 compartment. External noises, such as road noise, engine
noise, vibrations, etc., as well as noises emanating from
within passenger compartments, may be attenuated through
the use of various acoustical materials. Accordingly,
sound attenuating materials for vehicles, such as
20 automobiles, are conventionally used in the dashboard, in
conjunction with carpeting for floor panels, in the wheel
wells, in the trunk compartment, under the hood, and as
part of the headliner.

The attenuation of external noise is
25 conventionally referred to as sound transmission loss
(STL). The attenuation of internal noise is

conventionally referred to as sound absorption. The acoustic impedance of a material is defined as material density times acoustic velocity, and is expressed in units of Rayls (Newton-seconds/meter³). Acoustic impedance defines how easy it is for air to move through a material. Thus, for fibrous materials, acoustic impedance depends upon the density of the fibrous material and fiber diameter. Generally, the heavier the blanket and the finer the fibers, the higher the acoustic impedance. Moreover, thicker layers typically have more acoustic impedance than thin layers. The ability of a material to attenuate noise is conventionally defined by the material's STL, acoustic impedance, and absorption characteristics.

Carpeting used to cover the floor areas of vehicles, such as automobiles, is conventionally molded into a non-planar three dimensional contoured configuration which conforms to the contours of the vehicle floor so as to fit properly. In order to make the carpeting moldable and shape-sustaining, it is conventionally provided with a backing of thermoplastic polymer composition. The thermoplastic polymer backing also serves as a barrier to improve the sound deadening properties of the carpet assembly.

Dash insulators are often mounted to a vehicle firewall which separates the passenger compartment from an engine compartment. Dash insulators are designed to reduce the transmission of noise and heat from the engine compartment into the passenger compartment. Conventional dash insulators consist of an acoustical absorber such as an open-cell polyurethane foam or a resinated fiber pad which faces the fire wall, and a barrier sheet such as a heavily filled thermoplastic material. Dash insulator barriers are conventionally produced in a compounding process followed by an extrusion or calendaring process or by an injection molding process to achieve a barrier

sheet of desired thickness and width.

Fig. 1 illustrates a conventional dash insulator **10** for reducing noise and heat transmitted from an engine compartment of a motor vehicle **12** into a passenger compartment. The dash insulator **10** is adapted to be mounted inside the passenger compartment of the vehicle against substantially the width of a fire wall **14** that separates the engine compartment from the passenger compartment.

Vehicle instrument panels are generally located behind the steering wheel of a vehicle and include a number of gauges or other displays for providing a driver with information about vehicle conditions. In addition, air vents for distributing cooled and heated air throughout a passenger compartment are often mounted within an instrument panel. Instrument panels are conventionally mounted onto a vehicle firewall with the dash insulator disposed therebetween. **Fig. 2** illustrates a conventional instrument panel **20**. The illustrated instrument panel **20** includes an instrument cluster area **22**, air vents **24**, central console area **26** and glove box **28**.

Fig. 3 illustrates a conventional automotive carpet assembly **30**. The illustrated carpet assembly **30** has a nonplanar three dimensional molded configuration adapted to fit in the front seat compartment of an automobile and includes a raised medial portion **31** adapted to conform to the transmission hump, generally vertically extending side portions **32** adapted to fit beneath the door opening, and a front portion **33** adapted to fit along the inclined floorboard and portions of a vehicle firewall. Various openings or cut-outs are provided, as indicated at **34**, to receive air conditioning equipment, the steering column, pedals and the like.

During vehicle manufacturing, dash insulators,

instrument panels and floor coverings are typically installed separately. In addition, the installation of dash insulators, instrument panels and floor coverings can be complex and labor intensive. As such, vehicle
5 manufacturers are continuously looking for ways to reduce costs and complexity associated with vehicle manufacturing.

U.S. Patent No. 4,597,461 to Kochy et al. describes a pre-assembled module for the cockpit zone of
10 a motor vehicle, which is adapted to be mounted as one single unit inside the vehicle body and which incorporates essentially the following components: an instrument board including all instruments and accessories commonly contained therein, fuse box and
15 electric wiring, heater with controls and air distribution system; furthermore a steering system including steering wheel, steering column enclosure and steering support means; also pedals for clutch and brake, including mounting brackets. The vehicle body includes a
20 fire wall and fire wall support member to which the aforementioned components and accessories are connected when in the installed position. The fire wall and fire wall support member are separated from the body shell and serve as an assembly base for the unit. In the installed
25 position, the fire wall and fire wall support member are sealingly connected with the respective adjacent body panels.

SUMMARY OF THE INVENTION

30 In view of the above discussion, vehicle cockpit assemblies and methods of installing same within vehicles are provided. According to embodiments of the present invention, a vehicle cockpit assembly includes a dash insulator that is configured to be attached in face-
35 to-face contacting relationship to a vehicle firewall, an instrument panel attached to the dash insulator, and a

floor covering (e.g. molded carpet assembly) also attached to the dash insulator. The dash insulator includes a substrate having opposite first and second surfaces and opposite first and second edge portions. A plurality of apertures are formed through the substrate, each of which is configured to overlies a respective opening in a vehicle firewall when attached thereto. Each aperture is configured to sealably receive an item (e.g., air conditioning equipment, steering column, pedals and the like) extending therethrough between the engine and passenger compartments such that substantially no gaps exist between the item and the substrate. Polyurethane (or other sound attenuation material) may be added to one or more selected portions of the substrate first and/or second surfaces. The polyurethane may be configured to reflect and/or absorb sound directed to the dash insulator.

The instrument panel is attached to the substrate first edge portion. Preferably, the instrument panel and dash insulator are movably attached to each other to facilitate installation thereof within a vehicle. The floor covering is attached to the dash insulator substrate second edge portion. Preferably, the floor covering and dash insulator are movably attached to each other to facilitate installation thereof within a vehicle.

According to embodiments of the present invention, a vehicle cockpit assembly includes a dash insulator having two, separate portions: an upper substrate having opposite first and second surfaces and opposite first and second edge portions, and a lower substrate having opposite third and fourth surfaces and opposite third and fourth edge portions. An instrument panel is attached to the upper substrate first edge portion, and a floor covering is attached to the lower substrate fourth edge portion.

According to embodiments of the present invention, the instrument panel is movably attached to the upper substrate first edge portion such that movement of the instrument panel relative to the upper substrate facilitates installation of the cockpit assembly within a vehicle passenger compartment during vehicle assembly. Similarly, the floor covering may be movably attached to the lower substrate second edge portion such that movement of the floor covering relative to the lower substrate facilitates installation of the cockpit assembly within a vehicle passenger compartment during vehicle assembly. The upper and lower dash insulator substrates are configured to be joined together along the respective second and third edge portions. Upon installation of the upper and lower substrates within a vehicle, the respective second and third edge portions are joined together.

According to embodiments of the present invention, operations for installing a vehicle cockpit assembly within a passenger compartment of a vehicle include providing a dash insulator that is configured to be attached to a vehicle firewall, attaching an instrument panel to an upper portion of the dash insulator, attaching a floor covering to a lower portion of the dash insulator, ascertaining acoustic properties of the vehicle to identify portions of the dash insulator requiring sound reflection and/or absorption, applying sound reflection and/or absorption material to identified portions of the dash insulator, and installing the cockpit assembly within a vehicle.

According to embodiments of the present invention, a dash insulator that is configured to be attached in face-to-face contacting relationship with a vehicle firewall includes a substrate having opposite first and second surfaces and opposite first and second edge portions, an opening formed through a portion of the

substrate, and a pass-through assembly having opposite first and second sides and a peripheral edge portion. The pass-through assembly first side is attached to the substrate second surface in face-to-face contacting relationship such that the substrate opening is covered by the pass-through assembly first side. The pass-through assembly is configured to be sealed against the firewall when the dash insulator is installed such that the firewall opening is covered by the pass-through assembly second side. The pass-through assembly includes one or more apertures formed therein, wherein each aperture is configured to receive an item extending therethrough. Various items can be attached to and/or extended through the pass-through assembly prior to installation of the dash insulator in a vehicle.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings, which form a part of the specification, illustrate key embodiments of the present invention. The drawings and description together serve to fully explain the invention.

Fig. 1 is a partial perspective view of a vehicle illustrating a conventional dash insulator for reducing noise and heat transmitted from an engine compartment into a passenger compartment via a firewall.

Fig. 2 is a perspective view of a conventional instrument panel for a vehicle.

Fig. 3 is a perspective view of a conventional carpet assembly for a vehicle.

Fig. 4 is a side elevation view of a vehicle cockpit assembly, according to embodiments of the present invention, taken along lines 4-4 of **Fig. 5** and illustrating an instrument panel and carpet assembly attached to a dash insulator.

Fig. 5 is a front plan view of a vehicle cockpit assembly according to embodiments of the present invention.

Fig. 6 is an enlarged, partial cross-sectional view of a dash insulator having polyurethane of different thicknesses applied thereto, according to embodiments of the present invention.

Fig. 7 is an enlarged, partial cross-sectional view of a dash insulator having an aperture that is configured to sealably receive an item extending therethrough such that no gaps exist between the item and the dash insulator.

Fig. 8 is a side elevation view of a vehicle cockpit assembly, according to embodiments of the present invention, and illustrating an instrument panel and carpet assembly attached to respective upper and lower separate portions of a dash insulator.

Fig. 9 is an enlarged, partial side-elevation view of the vehicle cockpit assembly of **Fig. 8** illustrating the attachment of the upper and lower dash insulator portions, according to an embodiment of the present invention.

Fig. 10 is a flowchart of operations for installing vehicle cockpit assemblies within passenger compartments of vehicles, according to embodiments of the present invention.

Figs. 11A-11B are respective front and rear plan views of a dash insulator having a pass-through assembly attached thereto, according to embodiments of the present invention.

Fig. 12 is a side elevation view of a vehicle cockpit assembly, according to embodiments of the present invention, and illustrating an instrument panel and carpet assembly attached to respective upper and lower separate portions of the dash insulator of **Figs. 11A-11B**.

DETAILED DESCRIPTION OF THE INVENTION

The present invention now is described more fully hereinafter with reference to the accompanying
5 drawings, in which preferred embodiments of the invention are shown. This invention may, however, be embodied in many different forms and should not be construed as limited to the embodiments set forth herein; rather, these embodiments are provided so that this disclosure
10 will be thorough and complete, and will fully convey the scope of the invention to those skilled in the art.

In the drawings, the thickness of lines, layers and regions may be exaggerated for clarity. It will be understood that when an element such as a layer,
15 region, substrate, or panel is referred to as being "on" another element, it can be directly on the other element or intervening elements may also be present. In contrast, when an element is referred to as being
20 "directly on" another element, there are no intervening elements present. It will be understood that when an element is referred to as being "connected" or "attached" to another element, it can be directly connected or attached to the other element or
25 intervening elements may also be present. In contrast, when an element is referred to as being "directly connected" or "directly attached" to another element, there are no intervening elements present. The terms "upwardly", "downwardly", "vertical", "horizontal" and the like when used herein are for the purpose of
30 explanation only.

Embodiments of the present invention provide vehicle cockpit assemblies and methods of installing same within vehicles that can reduce manufacturing costs and complexity. Referring to **Figs. 4-5**, a vehicle cockpit
35 assembly **40** according to embodiments of the present invention is illustrated. The vehicle cockpit assembly **40**

includes a dash insulator 10 that is configured to be attached in face-to-face contacting relationship to a vehicle firewall, an instrument panel 20 attached to the dash insulator 10, and a floor covering (e.g., molded carpet assembly) 30 also attached to the dash insulator 10. The dash insulator 10 includes a substrate 11 having a non-planar three dimensional molded configuration adapted to fit the firewall of a vehicle. It is to be understood that the particular three dimensional configuration illustrated is merely for purposes of illustration. Dashboard insulators according to embodiments of the present invention may have various configurations and shapes depending on the firewall configuration of a vehicle.

15 The substrate 11 may be formed from any type of material including, but not limited to foam (e.g., polyurethane foam, thermoplastic foam, etc.), barrier material, and other thermoformable fibrous materials including those derived from natural and synthetic
20 fibers. Barrier material is a relatively dense material, normally impermeable to air and thermoformable. Barrier material can be formed from virtually any plastic or rubber material which contains a high-mass filler material. An exemplary barrier material includes
25 ethylene-vinylacetate (EVA) copolymer, polyethylene, or polyvinyl-chloride (PVC), and a high-mass filler material, such as glass, calcium carbonate or barium sulfate, added to increase the mass. Other suitable materials for the substrate 11 include thermoformable
30 thermoplastic materials such as polystyrene, polyphenyl sulfide and polycarbonate, fiber-reinforced thermoplastics and fiber-reinforced thermosets such as epoxies, phenolics and the like, as well as various types of thermosetting materials.

35 The illustrated substrate 11 includes opposite

first and second surfaces 11a, 11b and opposite first and second edge portions 12a, 12b. A plurality of apertures 13 (Fig. 5) are formed through the substrate 11, each of which is configured to overlies a respective opening in a vehicle firewall when attached thereto. Each aperture 13 is configured to sealably receive an item (e.g., air conditioning equipment, steering column, pedals and the like) extending therethrough between the engine and passenger compartments such that substantially no gaps exist between the item and the substrate.

Sound attenuation material (e.g., polyurethane) may be added to one or more selected portions of the substrate first and/or second surfaces 11a, 11b. The sound attenuation material may be configured to reflect and/or absorb sound directed to the dash insulator 10. In the illustrated embodiment, a polyurethane barrier layer 14 is applied to selected portions of the substrate second surface 11b. The polyurethane barrier layer 14 may also be applied to the entire second surface 11b of the substrate 11. The polyurethane barrier layer 14 is non-porous and is configured to attenuate sound passing through a vehicle firewall and through the dash insulator 10.

According to embodiments of the present invention, substrate 11 and layer 14 may be the same material (e.g., impermeable barrier material). As an example, substrate 11 may be a barrier material with additional barrier material (e.g., sprayable polyurethane) 14 added to one or more selected portions of the substrate 11. Furthermore, substrate 11 may have variable thickness.

According to other embodiments of the present invention, a porous material (e.g., a foam or fiber decoupler layer) may be added as a layer to one or more portions of the substrate 11. A fibrous decoupler layer

may include natural and/or manmade fibers.

According to embodiments of the present invention, a non-porous polyurethane barrier layer 14 may have a specific gravity of between about 1.0 and about 2.0, and may have a thickness of between about 1 millimeter (mm) to about 8 mm.. The polyurethane barrier layer 14 may comprise an isocyanate, a polyol and various additives such as crosslinking agents, catalysts, the selection of which will be within the skill of one in the art. For example, the isocyanate component of the polyurethane includes one or more compounds selected from the group consisting of diphenylmethane-4, 4'-diisocyanate, diphenyldimethylmethane-4, 4'-diisocyanate, phenylene-1, 4-diisocyanate, 2,2',6,6'-tetramethyldiphenylmethane-4,4'-diisocyanate, diphenyl-4, 4'-diisocyanate, diphenylether-4, 4'-diisocyanate or its alkyl-, alkoxy- or halogen-substituted derivatives, toluylene-2, 4- and -2,6-diisocyanates or their commercially available mixture, 2,4-diisocyclopropylphenylene-1, 3-diisocyanate, m-xylylenediisocyanate, and p-xylylenediisocyanate.

Further, in the practice of the present invention, any desired types of polyester polyols and polyether polyols may be used as a polyol component of the polyurethane prepolymer solution. Examples of the crosslinking agent usable in the present invention include trifunctional or more functional polyisocyanate or hydroxyl compounds, for example, one or more compounds selected from the group consisting of ethylene glycol, propylene glycol, butane-1, 4-diol, hexane-2, 5-diol, 2,2-dimethylpropane-1, 3-diol, hexane-1,6-diol, 2-methylhexane-1,6-diol, 2,2-dimethylhexane-1,3-diol, p-bishydroxymethyl cyclohexane, 3-methylpentane-1, 4-diol, 2,2-diethylpropane-1, 3-diol and the like. As the catalyst, tertiary amines, organic tin compounds, organic lead compounds and the like may be used. As the solvent

capable of dissolving polyols and isocyanates, methyl ethyl ketone, ethyl acetate, toluene, xylene, dimethylformamide, methyl isobutyl ketone, butyl acetate, acetone or the like may be used alone or in combination.

5 According to embodiments of the present invention, the polyurethane barrier layer **14** may include a filler, such as calcium carbonate, calcium hydroxide, aluminum trihydrate, talc, bentonite, barytes, silica, clay and mica.

10 An exemplary polyurethane barrier material that may be used in accordance with embodiments of the present invention is Bayer Elastomer (Bayer AG, Pittsburgh, PA). Another exemplary polyurethane barrier material that may be used in accordance with embodiments of the present
15 invention is Huntsman Rimline SH 80309 (Huntsman Corporation, Salt Lake City, Utah).

 As illustrated in **Fig. 6**, the polyurethane barrier layer **14** may have a first thickness in a first location **14a** and a second thickness greater than the
20 first thickness in a second location **14b**.

 According to embodiments of the present invention, polyurethane applied to a dash insulator **10** according to embodiments of the present invention may be a breathable polyurethane such that sound absorption
25 characteristics of the dashboard insulator **10** are enhanced. Moreover, there may be a combination of breathable polyurethane and non-porous polyurethane such that both sound absorption and sound attenuation characteristics of the dashboard insulator **10** are
30 enhanced.

 According to the illustrated embodiment of **Figs. 4-5**, the instrument panel **20** is attached to the substrate first edge portion **12a**. Attachment may be via polyurethane or other curable adhesive material applied
35 to the dash insulator **10**, instrument panel **20**, or both

during molding of these components. Preferably, the instrument panel 20 and dash insulator 10 are movably attached to each other. A hinge or other device known to those skilled in the art may be utilized. Polyurethane or other adhesive material may be applied so as to serve the function of a hinge, thereby permitting movement of the instrument panel 20 relative to the dash insulator 10. Movement of the instrument panel 20 relative to the dash insulator 10 can facilitate installation thereof within a vehicle.

According to embodiments of the present invention illustrated in **Figs. 4-5**, a floor covering (e.g., a carpet assembly) 30 is attached to the dash insulator substrate second edge portion 12b. It is to be understood that the particular carpet assembly configuration illustrated is merely for purposes of illustration, and the actual configuration may vary quite significantly from that shown depending on the automobile within which it is attached.

Attachment of the floor covering 30 to the dash insulator 10 may be via polyurethane or other curable adhesive material applied to the dash insulator 10, floor covering 30, or both during molding of these components. Preferably, the floor covering 30 and dash insulator 10 are movably attached to each other. A hinge or other device known to those skilled in the art may be utilized. Polyurethane or other adhesive material may be applied so as to serve the function of a hinge, thereby permitting movement of the floor covering 30 relative to the dash insulator 10. Movement of the floor covering 30 relative to the dash insulator 10 can facilitate installation thereof within a vehicle.

Referring to **Fig. 7**, an aperture 13 in the illustrated dash insulator 10 is illustrated in more detail. The aperture 13 includes a secondary article

(e.g., a plastic pass-through) 50 that is molded-in with the dash insulator substrate 11. The secondary article 50 is sized and configured to sealably receive an item extending therethrough such that substantially no gaps exist between the item and the substrate 11. As such, sound cannot "leak through" the aperture 13 as may often be the case in conventional dash insulators.

Referring to **Fig. 8**, a vehicle cockpit assembly 40' configured to be installed within a passenger compartment of a vehicle, according to other embodiments of the present invention is illustrated. The dash insulator 10 is comprised of two portions: an upper substrate 60 having opposite first and second surfaces 60a, 60b and opposite first and second edge portions 61a, 61b, and a lower substrate 62 having opposite third and fourth surfaces 62a, 62b and opposite third and fourth edge portions 63a, 63b.

An instrument panel 20 is attached to the upper substrate first edge portion 61a, and a floor covering 30 is attached to the lower substrate fourth edge portion 63b. According to embodiments of the present invention, the instrument panel 20 is movably attached to the upper substrate first edge portion 61a (e.g., via a hinge, or otherwise as described above with respect to the embodiments of **Figs. 4-5**), such that movement of the instrument panel 20 relative to the upper substrate 60 facilitates installation of the cockpit assembly 40' within a vehicle passenger compartment during vehicle assembly. Similarly, the floor covering 30 may be movably attached to the lower substrate second edge portion 63b (e.g., via a hinge, or otherwise as described above with respect to the embodiments of **Figs. 4-5**), such that movement of the floor covering 30 relative to the lower substrate 62 facilitates installation of the cockpit

assembly 40' within a vehicle passenger compartment during vehicle assembly.

The upper and lower substrates 60, 62 are configured to be joined together along the respective second and third edge portions 61b, 63a. Upon
5 installation of the upper and lower substrates 60, 62 within a vehicle, the respective second and third edge portions 61b, 63a are adhesively joined together. According to embodiments of the present invention
10 illustrated in **Fig. 9**, the second edge portion 61b is configured with a groove 70. A layer of adhesive 72 is disposed within the groove 70. The third edge portion 63a includes a raised portion 74 that is configured to matingly engage with the groove 70. The adhesive layer 72
15 maintains the upper and lower substrates in joined relationship.

According to embodiments of the present invention, the groove 70 and raised portion 74 may be reversed. That is, the third edge portion 63a may include
20 a groove and the second edge portion 61b may contain a raised portion that is configured to matingly engage with the groove.

Various types of adhesives known to those skilled in the art may be utilized. Various other ways of
25 joining the upper and lower substrates together may be utilized, as would be known to those skilled in the art. Embodiments of the present invention are not limited to the embodiments illustrated herein.

Referring now to **Fig. 10**, operations for
30 installing a vehicle cockpit assembly within a passenger compartment of a vehicle, according to embodiments of the present invention, include ascertaining acoustic properties of the vehicle to identify portions of the dash insulator requiring sound reflection and/or
35 absorption (Block 100), providing a dash insulator that

is configured to be attached to the vehicle firewall (Block 110), attaching an instrument panel to an upper portion of the dash insulator (Block 120), attaching a floor covering to a lower portion of the dash insulator (Block 130), applying sound reflection and/or absorption material to identified portions of the dash insulator requiring sound reflection and/or absorption (Block 140), and installing the cockpit assembly within a vehicle (Block 150).

10 An instrument panel and floor covering may be movably attached to a dash insulator as described above to facilitate installing the vehicle cockpit assembly within a vehicle. Acoustic properties of a vehicle may be ascertained (Block 100) by identifying areas of a
15 firewall through which sound within a predetermined frequency range passes at an intensity level that exceeds a threshold intensity level. Identifying areas of a firewall through which sound within a predetermined frequency range passes at an intensity level that exceeds
20 a threshold intensity level may include generating a sound intensity map of the vehicle and/or firewall. Sound intensity maps are well understood by those skilled in the art and need not be described further herein.

 Applying sound reflection and/or absorption
25 material to identified portions of the dash insulator (Block 140) may include spraying polyurethane (or other materials) to one or more portions of the dash insulator. In addition, polyurethane may be applied to one or more portions of a dash insulator with varying thickness.
30 Other techniques for applying polyurethane may be utilized. Polyurethane is applied to a dash insulator in areas identified as requiring enhanced sound attenuation characteristics. This may encompass applying additional polyurethane directly onto an existing polyurethane
35 barrier layer and/or into one or more recessed portions formed within the substrate. Areas of the dash insulator

in which apertures are to be formed therethrough are preferably avoided during the application of polyurethane.

As is known to those skilled in the art, a dash
5 insulator may be formed from multiple layers of material, such as polyurethane. Additional layers may be added in areas requiring enhanced sound attenuation characteristics.

A vehicle cockpit assembly according to
10 embodiments of the present invention may include a dash insulator having upper and lower portions, as described above. Accordingly, installing the cockpit assembly within a vehicle (Block 150) may include separately installing the upper and lower dash insulator portions
15 (with respective instrument panel and floor covering attached thereto) and then securing the upper and lower dash insulator portions together within the vehicle.

According to embodiments of the present invention, various ones of the operations illustrated in
20 **Fig. 10** may be performed out of the illustrated order. For example, polyurethane may be added to various portions of a dash insulator prior to dash insulator forming (*i.e.*, molding) operations. As another example, a substrate may be formed prior to the application of any
25 polyurethane. As another example, polyurethane may be applied within a mold and additional polyurethane added in selected locations. A substrate may then be attached to the polyurethane and the composite article formed via the mold into a desired shape.

30 Furthermore, operations represented by various blocks may be performed substantially simultaneously. For example, additional polyurethane can be added by adjusting processing speeds and/or by adjusting dispensing pressure, as would be understood by those
35 skilled in the art.

Referring to **Figs. 11A-11B**, a dash insulator

210 that is configured to be attached to a vehicle firewall in face-to-face contacting relationship therewith, according to another embodiment of the present invention, is illustrated. The dash insulator 210
5 includes a substrate 211 having a non-planar three dimensional molded configuration adapted to fit the firewall of a vehicle. It is to be understood that the particular three dimensional configuration illustrated is merely for purposes of illustration. Dashboard insulators
10 according to embodiments of the present invention may have various configurations and shapes depending on the firewall configuration of a vehicle.

The substrate 211 may be formed from any type of material including, but not limited to foam (e.g.,
15 polyurethane foam, thermoplastic foam, etc.), barrier material (as described above), and other thermoformable fibrous materials including those derived from natural and synthetic fibers. Other suitable materials for the substrate 211 include thermoformable thermoplastic
20 materials such as polystyrene, polyphenyl sulfide and polycarbonate, fiber-reinforced thermoplastics and fiber-reinforced thermosets such as epoxies, phenolics and the like, as well as various types of thermosetting materials. Sound attenuation material (e.g.,
25 polyurethane) may be added to one or more selected portions of the substrate first and/or second surfaces 211a, 211b as described above.

The illustrated substrate 211 includes opposite first and second surfaces 211a, 211b and opposite first
30 and second edge portions 212a, 212b. A plurality of apertures 213 are formed through the illustrated substrate 211, each of which is configured to overlie a respective opening in a vehicle firewall when the dash insulator 210 is attached thereto. Each aperture 213 may
35 be configured to sealably receive an item extending

therethrough between the engine and passenger compartments as described above.

The illustrated substrate 211 also includes an opening 215 formed through a portion thereof. A pass-through assembly (also referred to as a "mod plate") 216 is attached to the dash insulator second surface 211b such that it overlies the opening 215. The illustrated pass-through assembly 216 includes opposite first and second sides 216a, 216b and a peripheral edge portion 217. The pass-through assembly first side 216a is attached to the substrate second surface 211b in face-to-face contacting relationship such that the substrate opening 215 is covered by the pass-through assembly first side 216a. The pass-through assembly 216 is configured to be sealed against the firewall when the dash insulator is installed such that the firewall opening is covered by the pass-through assembly second side. The peripheral edge portion 217 of the illustrated pass-through assembly 216 has a raised portion 217a that compresses to thereby serve as a seal when the pass-through assembly first side 216a is in face-to-face contacting relationship with the substrate second surface 211b.

The illustrated pass-through assembly 216 includes multiple apertures 218a-218d formed therein. Each aperture 218a-218d is configured to receive an item extending therethrough. In the illustrated embodiment, an electrical cable harness 220 extends through aperture 218a and is sealably secured in the aperture 218a via a seal 222 that prevents gaps between the electrical cable harness 220 and the substrate 211. A steering wheel column 224 extends through aperture 218b and is sealably secured in the aperture 218b via a seal 226 that prevents gaps between the steering wheel column 224 and the substrate 211.

In the illustrated embodiment, a vehicle brake pedal assembly 230 secured to the pass-through assembly first side 216a via the substrate opening 215. A vehicle brake master cylinder assembly 240 is secured to the pass-through assembly second side 216b and is operably connected to the brake master cylinder assembly 230 via an aperture 233 in the pass-through assembly 216. In the illustrated embodiment, a vehicle accelerator pedal assembly 250 is secured to the pass-through assembly first side 216a via the substrate opening 215. An accelerator linkage (e.g., a cable) 252 and is operably associated with the accelerator pedal assembly 250 and extends through aperture 218d in the pass-through assembly 216. The cable 252 is sealably secured in the aperture 218d via a seal 228 that prevents gaps between the cable 252 and the substrate 211.

Embodiments of the present invention are not limited to the illustrated configuration of the pass-through assembly 216. Pass-through assemblies having various shapes and sizes, and having various apertures therethrough may be utilized in accordance with embodiments of the present invention.

By integrating various components to dash insulators as described above prior to installation within vehicles, costs and complexity associated with vehicle manufacturing can be reduced. Moreover, sound attenuation can be greatly enhanced by sealing the various items that extend through dash insulators.

Referring to **Fig. 12**, a vehicle cockpit assembly 340 incorporating the dash insulator of **Figs. 11A-11B** is illustrated. The vehicle cockpit assembly 340 includes an instrument panel 20 attached to the dash insulator 210, and a floor covering (e.g., molded carpet assembly, etc.) 30 also attached to the dash insulator 210. The instrument panel 20 and floor covering 30 may be

attached to the dash insulator 210 in various ways as described above.

The foregoing is illustrative of the present invention and is not to be construed as limiting thereof.

5 Although a few exemplary embodiments of this invention have been described, those skilled in the art will readily appreciate that many modifications are possible in the exemplary embodiments without materially departing from the novel teachings and advantages of this

10 invention. Accordingly, all such modifications are intended to be included within the scope of this invention as defined in the claims. Therefore, it is to be understood that the foregoing is illustrative of the present invention and is not to be construed as limited

15 to the specific embodiments disclosed, and that modifications to the disclosed embodiments, as well as other embodiments, are intended to be included within the scope of the appended claims. The invention is defined by the following claims, with equivalents of the claims to

20 be included therein.